

WHAT IS CLAIMED IS:

1 1. A method for providing a virtual private network service, comprising:
2 establishing a hose for each of a plurality of endpoints of a virtual private
3 network;
4 coupling the hose to endpoints associated with other hoses via routing
5 paths in a network; and
6 allocating network resources to support communications between the hose
7 and the other hoses.

1 2. The method of claim 1, wherein the establishing comprises specifying a
2 service level agreement for the hose, the service level agreement including a hose profile
3 and other information for controlling and managing the hose.

1 3. The method of claim 2, wherein the establishing comprises:
2 first selecting one of a user managed hose type or a virtual private network
3 service provider managed hose type for the hose; and
4 second selecting whether to transmit marked data packets to the hose,
5 results of the first and second selecting steps being stored in the hose profile.

1 4. The method of claim 3, wherein if the user managed hose type is selected,
2 the method further comprising:
3 specifying one or more aggregate bandwidths for the hose; and
4 specifying a time schedule for each of the aggregate bandwidths, the
5 aggregate bandwidths and the time schedule being stored in the hose profile.

1 5. The method of claim 4, wherein if data packet marking is selected, the
2 method further comprising:
3 receiving information regarding data packet markings and a quality of
4 service corresponding to each of the data packet markings; and
5 initializing the allocated network resources to provide the quality of
6 service based on the data packet markings if conditions in the hose profile is not violated.

1 6. The method of claim 3, wherein if the virtual service provider managed
2 hose type is selected, the method further comprising:
3 receiving one or more quality of service levels for the hose;

4 establishing one or more sub-virtual private networks, each sub-virtual
5 network corresponding to one of the quality of service levels;

6 specifying one or more bandwidths for the hose corresponding to each of
7 the sub-virtual private networks; and

8 specifying one or more time schedules for the bandwidths, the bandwidths
9 and the time schedules being stored in the hose profile.

1 7. The method of claim 6, wherein if data packet marking is selected, the
2 method further comprising:

3 receiving information regarding data packet markings and a quality of
4 service corresponding to each of the data packet markings; and

5 initializing the allocated network resources to provide the quality of
6 service based on the data packet markings if conditions in the hose profile is not violated.

1 8. The method of claim 2, further comprising:

2 measuring communication traffic of allocated network resources to
3 generate monitoring data;

4 generating a resizing condition based on the monitoring data; and

5 resizing the allocated network resources if the resizing condition is within
6 one or more thresholds of the hose profile.

1 9. The method of claim 8, wherein the monitored data includes historical
2 data, the method further comprising generating trend data to predict virtual private
3 network usage.

1 10. The method of claim 8, wherein the resizing condition is one of above an
2 upper bound threshold, below a lower bound threshold, and within the upper bound and
3 lower bound thresholds.

1 11. The method of claim 10, further comprising:

2 reducing the allocated network resources if the resizing condition is below
3 the lower bound threshold; and

4 increasing the allocated network resources if the resizing condition is
5 above the upper bound threshold.

1 12. The method of claim 10, wherein if the resizing condition is below the
2 lower bound threshold by a predetermined amount, the method further comprising

3 renegotiating the hose profile to change the service level agreement to be more consistent
4 with the monitored data.

1 13. The method of claim 10, wherein if the resizing condition is above limits
2 set by the hose threshold, the method further comprising renegotiating the hose profile to
3 change the service level agreement to be more consistent with the monitored data.

1 14. The method of claim 8, wherein the resizing condition determined based
2 on a prediction of future virtual private network usage.

1 15. The method of claim 1, wherein the routing paths is determined based on
2 one or more of:

3 network connectivity;
4 a hose identification; and
5 virtual private network identification.

1 16. The method of claim 15, further comprising selecting the routing paths
2 based on a shortest distance between pairs of endpoints of the virtual private network to
3 form a pe between the pairs of the endpoints.

1 17. The method of claim 15, further comprising:
2 selecting the routing paths based on a source tree or a sink tree for each of
3 the endpoints; and

4 minimizing a bandwidth allocation between nodes of the network by
5 maximizing sharing of same paths for branches of the source or the sink tree extending
6 between different ones of the endpoints.

1 18. The method of claim 15, further comprising:
2 selecting the routing paths based on source trees or sink trees
3 corresponding to all endpoints of the virtual private network; and
4 minimizing a bandwidth allocation between nodes of the network by
5 maximizing sharing of same paths for branches of the source or the sink trees extending
6 between different ones of the endpoints.

1 19. The method of claim 15, further comprising:
2 selecting the routing paths based on source trees or sink trees
3 corresponding to all endpoints of one or more virtual private networks; and

4 minimizing a bandwidth allocation between nodes of the network by
5 maximizing sharing of same paths for branches of the source or the sink trees extending
6 between different ones of the endpoints for all the virtual private networks.

1 20. The method of claim 1, wherein the network is an Internet Protocol
2 Network.

1 21. A virtual private network in an network, comprising:
2 a plurality of endpoints, each of the endpoints having a hose; and
3 a plurality of routing paths in the network, the routing paths coupling the
4 hose to endpoints associated with other hoses; and
5 a virtual private network service provider; the virtual private network
6 service provider allocating network resources to support communications between the
7 hose and the other hoses.

1 22. The virtual private network of claim 21, wherein the virtual private
2 network service provider receives a service level agreement for the hose, the service level
3 agreement including a hose profile and other information for controlling and managing
4 the hose.

1 23. The virtual private network of claim 22, wherein the virtual private
2 network service provider receives a first selection of one of a user managed hose type or a
3 virtual private network service provider managed hose type for the hose and a second
4 selection of whether to transmit marked data packets to the hose, results of the first and
5 second selections being stored in the hose profile.

1 24. The virtual private network of claim 23, wherein if the user managed hose
2 type is selected, the virtual private network service provider receives a specification for
3 one or more aggregate bandwidths for the hose, and a specification for a time schedule
4 for each of the aggregate bandwidths, the aggregate bandwidths and the time schedule
5 being stored in the hose profile.

1 25. The virtual private network of claim 24, wherein if data packet marking is
2 selected, the virtual private network service provider receives information regarding data
3 packet markings and a quality of service corresponding to each of the data packet
4 markings and initializes the allocated network resources to provide the quality of service
5 based on the data packet markings if conditions in the hose profile is not violated.

1 26. The virtual private network of claim 23, wherein if the virtual service
2 provider managed hose type is selected, the virtual private network service provider
3 receives one or more quality of service levels for the hose, establishes one or more sub-
4 virtual private networks, each sub-virtual network corresponding to one of the quality of
5 service levels, receives a specification of one or more bandwidths for the hose
6 corresponding to each of the sub-virtual private networks, and receives a specification of
7 one or more time schedules for the bandwidths, the bandwidths and the time schedules
8 being stored in the hose profile.

1 27. The virtual private network of claim 26, wherein if data packet marking is
2 selected, the virtual private network service provider receives information regarding data
3 packet markings and a quality of service corresponding to each of the data packet
4 markings, and initializes the allocated network resources to provide the quality of service
5 based on the data packet markings if conditions in the hose profile is not violated.

1 28. The virtual private network of claim 22, wherein the virtual private
2 network service provider measures communication traffic of allocated network resources
3 to generate monitoring data, generates a resizing condition based on the monitoring data,
4 and resizes the allocated network resources if the resizing condition is within thresholds
5 of the hose profile.

1 29. The virtual private network of claim 28, wherein the monitored data
2 includes historical data, the method further comprising generating trend data to predict
3 virtual private network usage.

1 30. The virtual private network of claim 28, wherein the resizing condition is
2 one of above an upper bound threshold, below a lower bound threshold, and within the
3 upper bound and lower bound thresholds.

1 31. The virtual private network of claim 30, wherein the virtual private
2 network service provider reduces the allocated network resources if the resizing condition
3 is below the lower bound threshold, and increases the allocated network resources if the
4 resizing condition is above the upper bound threshold.

1 32. The virtual private network of claim 30, wherein if the resizing condition
2 is below the lower bound threshold by a predetermined amount, the method further

3 comprising renegotiating the hose profile to change the service level agreement to be
4 more consistent with the monitored data.

1 33. The virtual private network of claim 30, wherein if the resizing condition
2 is above limits set by the hose threshold, the method further comprising renegotiating the
3 hose profile to change the service level agreement to be more consistent with the
4 monitored data.

1 34. The virtual private network of claim 28, wherein the resizing condition
2 determined based on a prediction of future virtual private network usage.

1 35. The virtual private network of claim 21, wherein the routing paths is
2 determined based on one or more of:

3 network connectivity;

4 a hose identification; and

5 virtual private network identification.

1 36. The virtual private network of claim 34, wherein the virtual private
2 network service provider selects the routing paths based on a shortest distance between
3 pairs of endpoints of the virtual private network to form a pipe between the pairs of the
4 endpoints.

1 37. The virtual private network of claim 34, wherein the virtual private
2 network service provider selects the routing paths based on a source tree or a sink tree for
3 each of the endpoints, and minimizes a bandwidth allocation between nodes of the
4 network by maximizing sharing of same paths for branches of the source or the sink tree
5 extending between different ones of the endpoints.

1 38. The virtual private network of claim 34, wherein the virtual private
2 network service provider selects the routing paths based on source trees or sink trees
3 corresponding to all endpoints of the virtual private network, and minimizes a bandwidth
4 allocation between nodes of the network by maximizing sharing of same paths for
5 branches of the source or the sink trees extending between different ones of the endpoints.

1 39. The virtual private network of claim 34, wherein the virtual private
2 network service provider selects the routing paths based on source trees or sink trees
3 corresponding to all endpoints of one or more virtual private networks, and minimizes a
4 bandwidth allocation between nodes of the network by maximizing sharing of same paths

$$\begin{array}{ccccccc} \mathbb{R}^{(m)} & \mathbb{R}^{(n)} & \mathbb{R} & \mathbb{R}^{(m)} & \mathbb{R}^{(n)} & \mathbb{R}^{(m)} & \mathbb{R}^{(n)} \\ \text{head} & \text{tail} & & \text{head} & \text{tail} & \text{head} & \text{tail} \end{array}$$